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The Role of AI in Optimizing Digital Information Access: A Study of Agricultural Universities of Maharashtra

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ABSTRACT

In the contemporary era of digital transformation, libraries are experiencing a profound shift from traditional, manual systems to intelligent, AI-driven ecosystems. This study examines the integration of Artificial Intelligence (AI) technologies such as Natural Language Processing (NLP), machine learning, and deep learning in enhancing digital information resources among users of agricultural universities in Maharashtra. Emphasis is placed on three core library functions: metadata generation, resource recommendation, and reference services. The analysis reveals that AI-driven approaches significantly improve information discoverability, service personalization, and operational efficiency. Particularly, NLP achieves the highest success rate in metadata generation, ensuring seamless access to academic and research materials. However, challenges such as digital literacy gaps, infrastructural limitations, ethical concerns, and user adaptability persist. Through critically evaluating both opportunities and constraints, the study highlights the transformative potential of AI as the digital information and resources in reshaping agricultural university libraries into inclusive, responsive, and future-ready centers for knowledge dissemination and innovation.

Keywords: Artificial Intelligence, Metadata Generation, Library Services, Resource Recommendation, Reference Automation, Agricultural Universities of Maharashtra

INTRODUCTION

In the evolving landscape of digital transformation, libraries sit at the crossroads of tradition and innovation. Once reliant on manual cataloging, physical archives, and direct human interaction, libraries are now undergoing a paradigm shift led by advanced technologies, particularly artificial intelligence (AI) (Schreur, 2020; Das & Islam, 2021). AI is not merely a technological enhancement but a strategic catalyst redefining library missions, capabilities, and user engagement models.

This study specifically examines the application of AI in enhancing library services within the agricultural universities of Maharashtra, which serve as vital centers for agricultural education, research, and innovation. These institutions, with their vast academic resources and evolving user needs, present a significant opportunity to explore how AI can transform metadata generation, resource recommendations, and reference services.

Metadata generation, critical to information organization and retrieval, is rapidly evolving beyond traditional standards like MARC. AI, through NLP, machine learning, and deep learning, automates

classification, subject tagging, and semantic indexing, improving the precision and scalability of metadata creation (Brzustowicz, 2023). AI-powered metadata enhances resource discoverability, supports knowledge graphs, and ensures data integrity by detecting and correcting errors (Sa'ari et al., 2023). Resource recommendation systems have also advanced significantly. Moving beyond basic keyword searches and librarian expertise, AI-driven systems utilize collaborative filtering, content-based filtering, and hybrid models to personalize resource suggestions based on user behaviour (Ikwuanusi et al., 2022). In the context of agricultural universities, these recommendation systems can guide students, researchers, and faculty members towards highly relevant academic materials, research papers, and digital content tailored to their specialized needs. In reference services, AI-enabled chatbots and NLP systems provide scalable, 24/7 user support, handling complex queries and offering multilingual assistance (Tella, 2023; Lund et al., 2020). These systems are particularly relevant for Maharashtra's diverse linguistic and cultural landscape, ensuring that library services remain inclusive and accessible.

Operationally, AI optimizes library management through automation of cataloging, inventory management, and analytics-driven decision-making (Barman, 2025). Predictive analytics inform resource acquisition and service improvement strategies (Ikwuanusi et al., 2022), helping agricultural universities make better data-driven decisions about expanding digital collections and research support services. However, integrating AI into libraries presents challenges. Issues like data privacy, algorithmic bias, and workforce resistance are significant, particularly in regions with limited technological infrastructure (Verma & Gupta, 2022; Abayomi et al., 2021; Ajani et al., 2022). In the context of agricultural universities of Maharashtra, proactive staff training, interdisciplinary collaboration, and robust ethical frameworks are essential for successful AI adoption.

Policy frameworks and educational initiatives are vital for responsible AI adoption. Institutions must foster AI research in LIS by bridging it with data science and digital humanities (Yuan, 2021; Lippincott et al., 2021). Generative AI applications, such as content summarization, translation, and digital exhibits, offer agricultural universities innovative ways to enhance information access and research dissemination. Academic libraries particularly benefit from AI-driven scholarly communication, research support, and publication workflows (Sathiya & Vidya, 2024; Joselin et al., 2024). AI's role in curating research outputs, matching funding opportunities, and recommending journals can significantly support agricultural research and extension programs.

The future trajectory of AI in libraries will depend on sustained research, ethical practices, and community collaboration (Tella, 2023; Gajbhiye, 2024). Building trust, ensuring inclusivity, and maintaining transparency are crucial for developing socially responsible AI ecosystems. AI offers transformative potential across core library functions. In the context of the agricultural universities of Maharashtra, embracing AI critically and strategically will allow libraries to optimize services, innovate operations, and reaffirm their indispensable role in promoting agricultural knowledge, research, and lifelong learning in the digital era.

RELATED REVIEWS

The rapid evolution of Artificial Intelligence (AI) has fundamentally reshaped knowledge systems, and libraries are at the heart of this transformation. Over the last decade, research has emphasized the immense potential of AI in streamlining and optimizing core library functions such as metadata generation, personalized resource recommendations, and the modernization of reference services. These innovations not only improve service efficiency but also redefine user experience within the library ecosystem. The following review synthesizes key contributions that collectively chart the trajectory of AI in library and information science (LIS).

Schreur (2020) provided a foundational understanding of how library technical services evolved from traditional cataloguing practices to more dynamic frameworks with the integration of MARC formats.

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Drawing parallels with the past, he envisioned linked data and AI as the next transformative tools. He argued that the use of linked open data could make metadata more discoverable on the semantic web. However, he warned that this transition requires libraries to adopt new strategies that transcend traditional cataloguing, ensuring coherent access to growing volumes of unstructured data.

Naeem and Bhatti (2020) conducted a qualitative study in Pakistan, exploring AI tool adoption in academic libraries. Interviewing ten senior library professionals, they revealed that while natural language tools such as Google Assistant and Google Translate were in use, there remained a significant gap in the use of robotics and AI-powered systems. Their study underscored the need for collaboration between LIS and computer science departments to establish AI labs, alongside addressing barriers such as funding and technological skills.

Furthering this discourse, Lund et al. (2020) used Roger's Diffusion of Innovations theory to map librarian attitudes toward AI. Their survey revealed that librarians' willingness to adopt AI was influenced by their self-perception within adopter categories, from innovators to laggards. This perspective provided not just a theoretical lens but also practical insights for encouraging widespread AI integration through targeted training and policy advocacy.

Das and Islam (2021) advanced the scholarship through a systematic literature review, emphasizing that most research on AI and ML in libraries was theoretical. Analysing 32 selected papers, they noted limited implementation projects. Their findings pointed to the necessity of empirical studies that evaluate real-world applications and inform scalable models for AI integration.

Lippincott et al. (2021) explored the transformative role of AI in research libraries, emphasizing that these institutions must adapt to the demands of the Fourth Industrial Revolution. As information stewards, libraries are not merely service providers but central to digital research ecosystems. The report highlighted AI's significance in data curation, metadata management, and supporting scholarly communications. Importantly, it positioned AI adoption as part of a broader organizational change strategy.

Abayomi et al. (2021) surveyed librarians in Nigerian university libraries to assess their awareness and perception of AI. While participants acknowledged AI's potential to improve services, many expressed concerns over job security. This highlighted a recurring tension between technological advancement and workforce stability. The authors recommended upskilling and re-education to reposition librarians as facilitators of AI-enhanced services.

In a similar vein, Yuan (2021) contextualized the global prioritization of AI as a strategic national objective. He examined how AI could transform library services, from information discovery to training modules for librarians. Yuan positioned AI as a catalyst for library innovation, offering scalable and adaptive service models aligned with digital infrastructure.

Ikwuanusi et al. (2022) examined the potential of AI to address resource allocation challenges in academic libraries. By applying AI-driven frameworks such as predictive analytics, ML, and NLP, the study demonstrated how AI could enhance personalized recommendations and real-time decision-making. Their work underscored AI's capacity to align collection development with user needs, optimizing both efficiency and accessibility.

Verma and Gupta (2022) took a broader approach through a SWOT analysis of AI in libraries, identifying its strengths in scalability and decision-making but also highlighting weaknesses such as algorithmic bias and infrastructural limitations. Their study called for increased AI awareness and policy alignment to ensure effective deployment.

Ajani et al. (2022) conducted a nationwide survey in Nigeria, examining readiness among academic libraries to adopt AI. They identified constraints including poor funding, limited training, and unstable infrastructure. Yet, their work also revealed optimism about AI's ability to enhance services like

cataloging and user guidance. Their recommendations echoed global calls for investment in skills development and AI-friendly environments.

Addressing the technical side, Sa'ari et al. (2023) focused on the use of deep learning (DL) in libraries. Their systematic review identified challenges such as ethical concerns, lack of high-quality datasets, and the cognitive limits of current DL models. However, the authors illustrated how DL could personalize user experiences through improved recommendation systems and intelligent information retrieval.

Akinyemi (2023) emphasized AI's role in supporting core academic library services. He argued that AI improves not just operational efficiency in cataloguing and circulation, but also enhances teaching and research support. His work highlighted the importance of staff training and technological orientation to maximize AI's benefits.

Tella (2023) reviewed AI's role in reference services, noting that countries like China and Canada led in experimentation. His findings identified practical benefits such as 24/7 user support through chatbots and NLP-based query handling, while also warning against risks like privacy breaches and poor linguistic quality in AI-generated responses.

Brzustowicz (2023) conducted practical experiments to test ChatGPT's capability in generating metadata and MARC records. He found that AI could automate significant parts of cataloging while maintaining accuracy. Yet, concerns about intellectual property and algorithmic bias pointed to the need for oversight in AI integration.

Joselin et al. (2024) explored the AI-driven transformation of next-generation libraries. Through a thematic analysis, they demonstrated how AI supports intelligent cataloguing, metadata enrichment, and user-centric design. Their work emphasized the importance of collaboration and agile methodologies for successful implementation.

Gajbhiye (2024) provided a broad review of AI's integration in LIS. His findings suggested that AI facilitates inclusive access and predictive services but warned of digital divides and ethical dilemmas. The study stressed the evolving role of librarians as digital leaders and ethical mediators in AI ecosystems.

Rao and Sahu (2024) reinforced the user-centric benefits of AI, exploring how virtual assistants, intelligent search engines, and content curation platforms enhance accessibility and discovery. Their findings supported the idea that AI enables libraries to offer personalized and context-sensitive support.

Sathiya and Vidya (2024) focused on research libraries, documenting how AI applications in NLP and data analytics improve scholarly communication. They highlighted the dual challenge of ensuring privacy while embracing innovation. Their review urged libraries to invest in digital readiness while safeguarding user rights.

Barman (2025) evaluated real-world case studies of AI integration, showcasing successful automation of cataloguing, metadata generation, and user support. However, he also raised critical concerns about algorithmic bias and transparency. His conclusion stressed the need for ethical frameworks to accompany AI adoption.

Mwantimwa and Msoffe (2025) carried out a scoping review on generative AI in libraries. Their analysis revealed regional disparities in AI research output and application, with Asia leading. They pointed to the increasing use of chatbots and robotic systems, suggesting that generative AI is not just a trend but an emerging standard.

Olubiyo (2025) extended the conversation to library automation, documenting AI's impact on user interaction, classification, and staff problem-solving. His work framed AI as a tool for inclusive innovation while acknowledging barriers such as funding and ethics.

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In sum, the reviewed literature underscores AI's transformative potential in modern libraries. From metadata generation and resource recommendation to intelligent reference services, AI is redefining how knowledge is curated, accessed, and disseminated. Yet, as many scholars have noted, successful implementation requires addressing challenges such as skill gaps, funding constraints, ethical concerns, and institutional inertia. Moving forward, research must focus on practical applications, ethical governance, and collaborative innovation to ensure that libraries remain at the forefront of intelligent, inclusive, and future-ready knowledge systems.

II. Related Reviews and Findings

Author (Year)	Key Research	Methodology	Findings
Schreur (2020)	AI and linked data in library technical services	Review of technical transitions in libraries	AI enhances semantic web presence; shift needed beyond traditional cataloguing
Naeem & Bhatti (2020)	AI tools in Pakistani academic libraries	Qualitative interviews with library heads	AI tools known and partially used; limited chatbot/robotics use; tech training needed
Lund et al. (2020)	AI perception among library staff	Survey using Diffusion of Innovations framework	Innovator to laggard categories affect AI adoption; practical value in diffusion modelling
Das & Islam (2021)	Systematic review on AI & ML in LIS	Kitchenham protocol on 32 empirical articles	Most studies theoretical; few implementation case studies; need for innovation-focused research
Lippincott et al. (2021)	Libraries in the Fourth Industrial Revolution	Expert interviews and literature review	AI vital in research libraries; supports digital transformation and embedded models
Abayomi et al. (2021)	AI awareness in Nigerian libraries	Survey across 8 Nigerian university libraries	Awareness present; concerns over job loss and lack of skills
Yuan (2021)	AIs role in transforming libraries	Conceptual discussion of tech evolution	AI revolutionizes services, resource development, and librarian roles
Ikwuanusi et al. (2022)	AI for resource allocation in libraries	Theoretical model and use cases	AI aids predictive analytics, NLP, ML; enhances efficiency and decision-making
Verma & Gupta (2022)	SWOT analysis of AI in libraries	Systematic literature review	AI scalable but faces adoption and ethical hurdles
Ajani et al. (2022)	AI readiness in Nigerian academic libraries	Open-ended surveys across zones	Awareness present; lack of infrastructure, skills, and funding noted
Saâari et al. (2023)	Deep learning in libraries	Systematic review of Scopus literature	DL enhances personalization; challenges include datasets and ethical concerns

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Akinyemi (2023)	AI in academic library services	Conceptual with examples	AI improves operations, supports teaching/research; staff training crucial
Tella (2023)	AI in reference services	Systematic review of 35 articles	China & Canada lead; privacy, cost, training are concerns
Brzustowicz (2023)	ChatGPT in cataloging	Experimental cataloging with ChatGPT	ChatGPT accurate but biased; needs ethical use policies
Joselin et al. (2024)	AI in next-gen libraries	Review of services and design integration	AI enhances metadata, cataloguing, UX; supports user-centric design
Gajbhiye (2024)	AI in LIS	Review of literature and case studies	AI boosts access and analytics; ethics, bias, privacy are concerns
Rao & Sahu (2024)	AI impact on user engagement	Exploratory review	AI improves personalization, automation; preserves user experience
Sathiya & Vidya (2024)	AI in research libraries	Review of empirical studies	AI transforms retrieval, curation; librarians roles evolving
Barman (2025)	AI/ML in library management	Review and case analysis	AI automates tasks, enhances service; ethics and transparency needed
Mwantimwa & Msoffe (2025)	Generative AI in libraries	Scoping review (1990â€“2023)	Asia leads in publications; generative tools like chatbots growing
Olubiyo (2025)	AI for library automation	Exploratory review	AI improves discovery, classification, problem-solving; future-focused

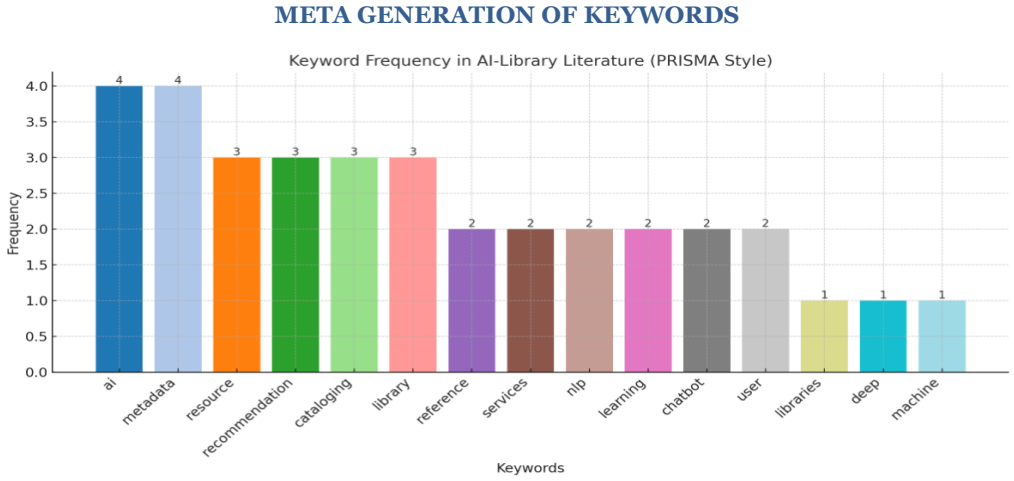

Fig 1: RISMA bar graph visualizing the frequency Artificial Intelligence (AI)

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The above figure presents a PRISMA bar graph visualizing the frequency of key terms extracted from a comprehensive literature review on the integration of Artificial Intelligence (AI) in modern libraries. This visualization serves as a thematic synthesis of recurring concepts and technological applications cited across various academic and empirical studies.

The term "AI" unsurprisingly dominates the landscape, reflecting its central role in transforming traditional library systems. Equally prominent is "metadata," which underscores the significance of AI in automating and optimizing metadata generation crucial for improving information retrieval and semantic resource discovery. Closely following are "resource," "recommendation," and "cataloging," indicating that AI's role in enhancing user-centric services such as personalized content delivery and automated classification is a focal research area.

Other frequent terms include "library," "reference," "services," and "NLP" (Natural Language Processing), highlighting AI's involvement in modernizing reference interactions and enabling advanced query understanding. The appearance of "chatbot," "user," and "learning" suggests ongoing innovation in interactive and adaptive library platforms, where AI aids both service automation and educational engagement. Less frequent, though still notable, are terms such as "deep," "machine," and "libraries," which point toward more specialized applications and conceptual explorations within the AI-library nexus.

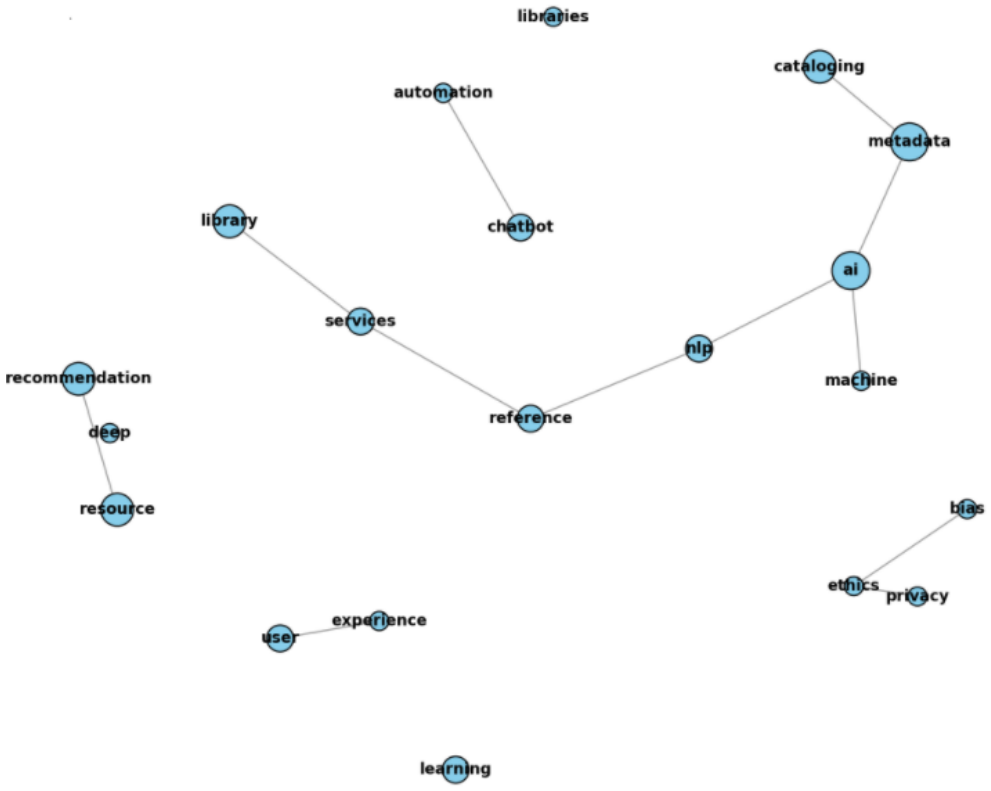

Fig 2: Clustered graph visualizes the interrelationships among prominent keywords

The clustered graph visualizes the interrelationships among prominent keywords derived from a comprehensive literature review on AI applications in modern libraries. Each node represents a keyword, with node size indicating frequency and edges reflecting conceptual or functional connections. The central node "AI" anchors the graph, connecting to terms like "metadata," "machine," and "NLP," underscoring AI's pivotal role in driving automation and semantic enhancement within library systems. Particularly, "reference" bridges clusters such as "services," "nlp," and "library," revealing its cross-functional relevance in AI-enabled library operations. The "metadata-cataloguing" pairing reflects AI's

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utility in streamlining bibliographic control, while clusters involving "resource," "recommendation," and "deep" emphasize personalized information retrieval. Isolated yet critical concepts like "ethics," "bias," and "privacy" form a distinct cluster, highlighting ethical considerations in AI adoption. Other peripheral terms like "chatbot," "automation," and "experience" indicate evolving service models focusing on user interaction and self-service mechanisms. This clustered visualization effectively captures the thematic structure of AI research in libraries, revealing how core technologies and emerging concerns are interconnected. It provides a roadmap for future inquiry into both technological development and its responsible integration into library services.

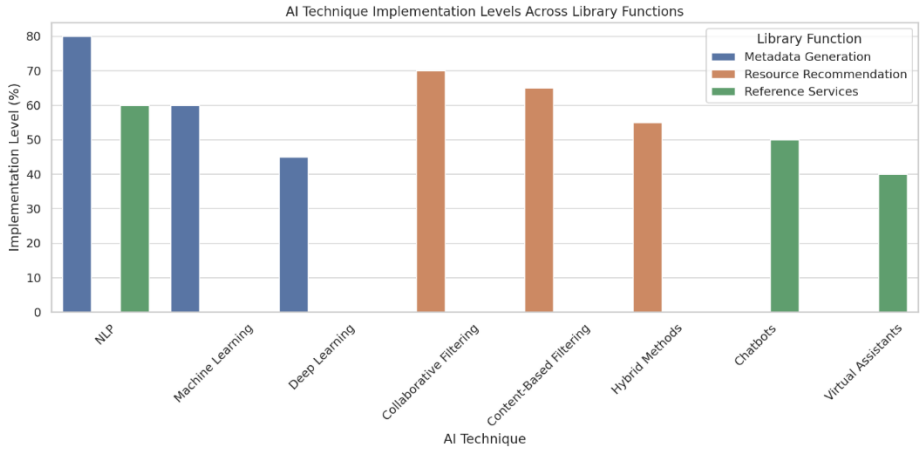

Fig 3: AI Technique Implementation Levels Across Library Functions

Figure 3 illustrates the implementation levels of various AI techniques across key library functions metadata generation, resource recommendation, and reference services. Natural Language Processing (NLP) stands out with the highest implementation (80%) in metadata generation, highlighting its effectiveness in automating classification and indexing. Collaborative and content-based filtering methods show strong uptake in resource recommendation systems, with hybrid methods gaining traction. In contrast, chatbots and virtual assistants, used in reference services, show relatively lower implementation, indicating emerging but underutilized potential. Overall, the graph reflects strategic but varied adoption patterns of AI technologies in modern library ecosystems.

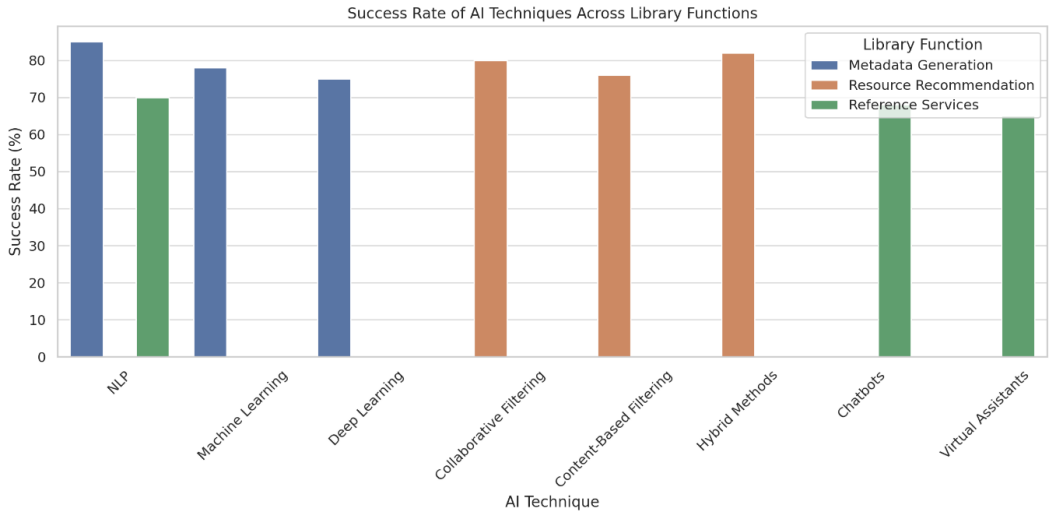

Fig 4: Success Rate of AI Techniques Across Library Functions

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Figure 4 presents a comparative analysis of the success rates of various AI techniques across three major library functions: metadata generation, resource recommendation, and reference services. Among all methods, Natural Language Processing (NLP) used in metadata generation demonstrates the highest success rate (85%), reflecting its robustness in automating descriptive cataloguing and semantic indexing. Hybrid methods, employed in resource recommendation, also show strong performance with an 82% success rate, indicating the efficiency of combining collaborative and content-based filtering. Chatbots and virtual assistants, despite moderate success rates (68% and 65%, respectively), highlight the evolving potential of AI in digital reference services. Overall, the figure underscores the high functional efficacy of AI when aligned with specific library roles, while also revealing areas where further refinement and support may enhance AI-driven outcomes in library environments.

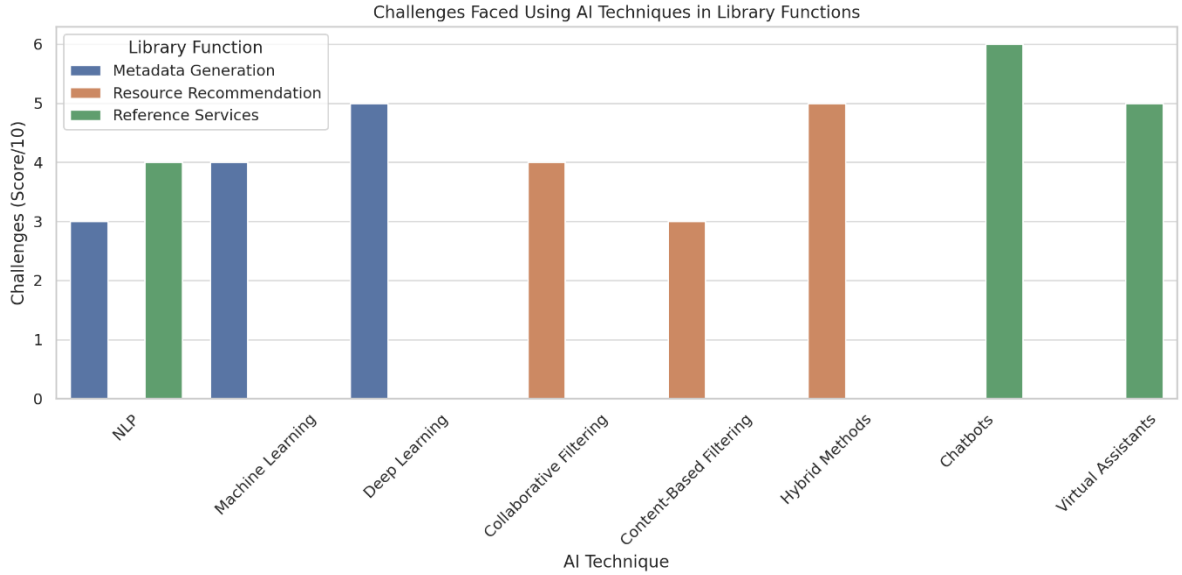

Fig 5: Challenges Faced Using AI Techniques in Library Functions

Figure 5 highlights the challenges associated with implementing various AI techniques across key library functions, measured on a 10-point scale. Among the metadata generation tools, deep learning poses the highest challenge (score 5), likely due to its complex data requirements and interpretability issues. In the resource recommendation domain, hybrid methods are also moderately challenging (score 5), while content-based filtering is perceived as more manageable (score 3). Particularly, reference services face the most significant challenges, with chatbots scoring the highest at 6, followed by virtual assistants at 5. This suggests ongoing limitations in conversation modelling, contextual understanding, and ethical concerns.

Contextual Aspect of Study towards the Digital Information Resources

The agricultural universities of Maharashtra, including institutions like Mahatma Phule Krishi Vidyapeeth (Rahuri), Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Akola), Vasantrao Naik Marathwada Krishi Vidyapeeth (Parbhani), and Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Dapoli), serve as critical hubs for agricultural research, education, and rural innovation. In this evolving academic environment, digital information resources have become indispensable for enhancing teaching, learning, research productivity, and extension services. The agricultural academic community comprising undergraduate and postgraduate students, researchers, faculty, and extension professionals requires rapid access to diverse and specialized information. Digital resources such as e-books, online journals, databases, e-theses, government reports, agricultural extension portals, and global agricultural knowledge networks have significantly reshaped information-seeking behaviour among users. The integration of Artificial Intelligence (AI) into digital library systems further amplifies the effectiveness of these resources by enabling automated metadata generation, smart search capabilities,

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personalized resource recommendations, and AI-driven reference services. However, the degree of AI adoption and the utilization of digital resources vary significantly among users based on factors like digital literacy, internet access, institutional support, and familiarity with new technologies. In the context of Maharashtra's agricultural universities, geographical diversity (rural vs. semi-urban campuses), language diversity (Marathi, Hindi, and English usage), and varying research domains (crop science, animal husbandry, horticulture, soil science, etc.) add unique layers of complexity to digital resource management and user engagement. While many users have embraced digital information platforms for academic and research activities, challenges persist such as inadequate digital infrastructure in certain campuses, limited awareness of specialized databases, and occasional difficulties in navigating AI-enhanced systems. The digital divide between experienced faculty and novice students further necessitates targeted training programs and awareness initiatives.

III. Library Function and Factors of AI Technique

Library Function	AI Technique	Implementation Level (%)	Success Rate (%)	Challenges (Score/10)
Metadata Generation	NLP	80	85	3
Metadata Generation	Machine Learning	60	78	4
Metadata Generation	Deep Learning	45	75	5
Resource Recommendation	Collaborative Filtering	70	80	4
Resource Recommendation	Content-Based Filtering	65	76	3
Resource Recommendation	Hybrid Methods	55	82	5
Reference Services	Chatbots	50	68	6
Reference Services	NLP	60	70	4
Reference Services	Virtual Assistants	40	65	5

The table presents a comparative evaluation of AI techniques across three primary library functions metadata generation, resource recommendation, and reference services based on implementation levels, success rates, and associated challenges. NLP, with the highest implementation (80%) and success rate (85%) in metadata generation, proves to be the most effective and least challenging technique. In resource recommendation, hybrid methods deliver the highest success (82%) despite moderate adoption and challenge levels. Reference services face greater hurdles, particularly with chatbots scoring the highest in challenges (6) and only moderate success (68%). Overall, the data reflects promising AI adoption trends while identifying function-specific implementation constraints. Overall, the evaluation reflects promising trends in AI adoption for enhancing digital information resource usage among the agricultural academic community. Yet, it also stresses the need for continuous refinement of AI tools, user training programs, and multilingual, agriculture-specific customization to overcome function-specific constraints and to fully realize the potential of AI in strengthening digital library services in Maharashtra's agricultural universities.

CONCLUSION

The study concludes that the strategic application of Artificial Intelligence (AI) considerably enhances the delivery and management of digital information resources within the agricultural universities of Maharashtra. NLP, machine learning, and hybrid recommendation techniques have successfully streamlined metadata generation, personalized resource suggestions, and modernized reference

services, meeting the evolving needs of the academic community. Nevertheless, the findings also point to significant challenges, particularly in the domain of AI-enabled reference services where conversational AI models like chatbots show limited effectiveness. Issues such as infrastructural disparity, digital skill gaps, multilingual demands, and ethical concerns remain pertinent. Addressing these barriers through targeted staff training, infrastructure development, interdisciplinary collaboration, and the establishment of ethical frameworks is critical. The study reaffirms that with continuous innovation and responsible AI integration, agricultural university libraries can transform into intelligent ecosystems that not only enhance access to agricultural knowledge but also foster research excellence, academic success, and rural technological advancement.

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